UTILIZING WEIGHTLIFTING FOR ROAD CYCLING PERFORMANCE

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INTRODUCTION: When prescribing an annual training for an athlete, the coach must consider methods best suited to influencing adaptations that are of importance to the specific sport. For road cycling performance, most training annual plans focus on modifications of duration and intensity of on-the-bike training (Faria et al., 2005). However, recent investigations have found improvements in cycling performance resulting from supplemental strength training programs (Aagaard et al., 2011; Rønnestad et al., 2010; Rønnestad et al., 2014), especially when the strength training is coupled with a reduction in the volume in cycling (Yamamoto et al., 2010). Although research has examined strength training over longer periods time (e.g. 25 weeks by Rønnestad et al., 2010), no research has presented an annual plan for concurrent training, which would seek to progress training in a periodized manner and peak performance for competition. Thus, the practical implications of strength training for a cycling coach are still lacking. In collegiate road cycling, athletes will compete in three events (time trial, criterium race, road/circuit race) per weekend. Each of these events can vary significantly in their intensity and time demands (Abbiss et al., 2010). Thus, the athlete must engage in a varied and extensive cycling training program for success. In order to be a practical training complement for this athlete, the supplemental strength training must be time-efficient and elicit adaptations that can relate to the actual demands of these varied events.

The purpose of this review is four fold: 1) briefly analyze the demands of competitive cycling 2) briefly summarize the findings of existing research on strength training for cycling performance 3) explain why a strength training program for cycling performance should by based on the weightlifting movements 4) present an example of an annual training plan for a collegiate cyclist incorporating weightlifting movements.

RESULTS: *Cycling Competition Analysis*: Recent investigations have employed the use of power meters to quantify and analyze the specifics of intensity and time from actual professional races (Abbiss et al., 2010; Abbiss et al., 2013; Ebert et al., 2006). A common theme expressed in the literature is the highly variable, stochastic nature of the demands of road cycling. Although event type (Abbiss et al., 2010) and terrain conditions (Ebert et al., 2006) significantly influence the race demands, great variability in power outputs has been reported over the duration of all races. For example, power output ranges as wide as 0 to 1665 have been observed (Ebert et al., 2006). Additionally, efforts at the high-end range above maximal aerobic often occur repeatedly in a race (Ebert et al., 2006; Abbiss et al., 2013), especially when breakaway attempts are made (Abbiss et al., 2013). A successful breakaway is usually an explosive effort, with a rapid increase in power output above 1000 watts, followed by a five to 15 second effort above 800 watts (Abbiss et al., 2013). Therefore, despite the aerobic nature of road cycling, the coach must also train the athlete to be capable to achieve a high range of power outputs, as well as initiate and respond to short, extremely powerful surges in intensity.

Strength Training and Cycling: Experimental research has found statistically greater improvements in prolonged time trial performance (40-45 minutes) with concurrent training, when compared to endurance only controls, despite no improvements in maximal oxygen capacity (Aagaard et al., 2011; Rønnestad et al., 2014). Although the exact mechanism through which strength training improves cycling performance have not been fully elucidated, several possible factors have been identified, including increased maximal strength, improved rate of force development, an increase in the proportion of type IIA muscle fibers (Aagaard et al., 2011), and improved pedaling dynamics, possibly due to improvements in strength and rate of force development (Rønnestad et al., 2014). Cross-sectional research has also highlighted the relationship between strength with cycling performance (Stone et al., 2004) and with muscle activation during pedaling (Bieuzem et al., 2007) in highly trained cyclists. Thus, improvements in maximal strength and rate of force development may be two of the underlying adaptations responsible for enhanced cycling performance after strength training.

DISCUSSION: Given the dynamics of cycling, the athlete has two methods to sustain high intensity and fast accelerations that characterize road racing: push more forcefully on the pedals (i.e. use a higher gear ratio) and increase pedal rate. Strength and rate of force development appear logically tied to these goals of producing high forces at a fast rate. As both maximal strength and rate of force development may decrease with prolonged endurance training and can be enhanced with strength training (Wilson et al., 2012), specifically targeting these variables through a supplementary strength training may be advantageous for the competitive cyclist. Of note is that cycling performance is often operationalized as a simulated time trial in the strength training research. Since the work rate of mass start races tend to be more stochastic than time trials (Abbiss et al., 2010), the true impact of increases in maximal strength and rate of force development may be greater than that reported from controlled research.

With the goal of increasing maximal strength and rate of force development, a resistance training plan including a progression of the weightlifting movements (snatch and clean and jerk) and their derivatives is recommended due to the superiority of these exercise in improving these variables over other forms of resistance training (Hoffman et al., 2004; Tricoli et al., 2005). Interestingly, previous research reporting strength and rate of force development have utilized more traditional strength training programs based on resistance training machines and focused only on muscles of the hips and lower limbs (Aagaard et al., 2011; Rønnestad et al., 2010; Rønnestad et al., 2014). One is left to speculate whether or not these adaptations were from the prescribed program per se, or rather the result from the initiation of resistance training program, in general. If so, a periodized and progressive program including the weightlifting movements should, in theory, elicit greater adaptations to strength, rate of force development, and ultimately cycling performance.

Annual Plan: The competitive collegiate road cyclist faces unique considerations when developing a plan to optimize performance. Over the competitive season, the athlete will partake in events every weekend during March and April, with national championships in early May. Each race weekend is usually comprised of three events distinctly events over two days: a time trial, a criterium race, and a circuit or road race. Further complicating programing for this athlete is the need to adequately balance the components of endurance and strength training to promote the intended adaptations to both, as the volume of aerobic training may impede the strength and force development adaptations (Wilson et al., 2012).

In order to optimize road cycling performance and balance the adaptations from concurrent training, a periodized annual plan based on the theoretical model proposed by Stone et al. (1982) is recommended. This strength training model uses phase potentiation to progress from initial goals of hypertrophy and strength, to basic strength, and then to strength and power. Phase potentiation capitalizes on the effects of one block, potentiating later blocks due to delayed gains in performance (Stone et al., 1982). If the athlete is unaccustomed to the weightlifting movements, initial priority should be placed on technique of the weightlifting movements and basic multi-joint exercises for general strength. During this time, cycling training should focus on general preparation and be as temporally removed from strength training as possible. As the athlete progresses, the exercises should become more complex, utilizing weightlifting derivatives, such as the clean pull, starting from the knee and ultimately from the floor. This progression will be accompanied by a gradual increase in intensity and decrease in volume, accomplished by a reduction in training frequency. As the athlete is in the competitive season, maintenance of strength training adaptations may be achieved by one session per week, if intensity is sufficient (Rønnestad et al., 2010). During this maintenance block emphasis should be placed on exercises that offer the greatest potential transfer of strength and rate of force development to the athlete's cycling abilities, such as the push jerk, mid-thigh pull, and the back squat.

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